

Role of Colour Doppler in Evaluation of Peripheral Arterial Diseases of Lower Limb Assuming CT Angiography as Gold Standard

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Abstract: Background: Peripheral arterial diseases (PAD) is an atherosclerotic occlusive condition which causes intermittent claudication and rest pain mainly in elderly males. The main aim is to identify the role of colour doppler in lower limb peripheral arterial disease. Material and Methods: A prospective study was conducted on 80 patients having clinical suspicion of PAD undergoing CDUS followed by CTA. A comparative analysis of arterial system was done by both gray scale and color spectrum doppler analysis on CDUS as well as by CTA for colour flow, % stenosis, length of involved segment, collateral flow, thrombus, plaque and wall calcification using chi square test. Results and discussion: Out of 640 arterial segments studied on both CTA and CDUS in our study, CTA picked up abnormality in 370 segments (57.85%) whereas colour Doppler was positive in 400 segments (62.5%). CDUS detected <50% stenosis in 220 arterial segments, 50-75% stenosis in 50 arterial segments, 75-99% stenosis in 10 arterial segments and occlusion (100% stenosis) in 90 arterial segments. Doppler overestimated the stenosis by 1 grade in 46 arterial segments and 2 grades in 2 arterial segment. Doppler underestimated the stenosis by 1 grade in 52 arterial segments. The overall sensitivity and specificity of CDUS compared to CTA in femoro popliteal segments was found to be 92.25% and 88.04% respectively. Overall PPV and NPV was 91% and 89.6% respectively. Conclusion: CDUS favours to be the 1st line investigation for evaluation of PADs followed by CT before planning any interventional treatment especially in femoropopliteal segments, low grade stenosis and eccentric stenosis.

Keywords: PAD, colour doppler, CT angiography

1. Introduction

Peripheral vascular diseases refers to the diseases of blood vessels outside the heart and brain which causes luminal narrowing of vessels. (1)

Patients with PAD may or may not be symptomatic. PAD causes limb ischemia by arterial stenosis which may manifest as intermittent claudication, rest pain, local tissue loss (ulceration) and potentially amputation. (2)

The most common cause of lower limb PADs is atherosclerosis [2]. Other less common causes include thromboembolism, acute thrombotic occlusion, trauma, vasculitis including vasospastic disorders and Buerger's disease.

Conventional DSA (Digital subtraction angiography) is considered as gold standard investigation for PAD but obsolete now as diagnostic tool because of its invasiveness because of arterial puncture, possible need for hospitalization, high radiation dose, and potential nephrotoxicity secondary to iodinated contrast agents.(3)

CT angiography mainly delineates the presence or absence of significant obstruction to the blood flow, the site or location and anatomical extent of obstruction, the status of collaterals and distal vasculature which is crucial for planning the treatment as well as to monitor the results of therapy and disease progression.(4). As there is pressing

need for identifying non-invasive method of evaluation of PADs which is safe, accurate, reliable, reproducible and cost effective. Doppler ultrasound fulfils most of these criterions with the advantage of being radiation free. Therefore, we had compared in our study the Doppler ultrasound with CT angiography characteristics in lower limb arteries.

2. Aim and Objectives

To identify the role of colour doppler in lower limb peripheral arterial disease with the following objectives-

- 1) To assess sensitivity, specificity, PPV, NPV of colour doppler in diagnosing PAD assuming CT angiography as gold standard.
- 2) To compare CT angiography and colour doppler imaging findings in evaluation of patients with peripheral arterial diseases.

3. Material and Methods

This was a hospital based cross sectional study conducted at department of Radiodiagnosis, SMS Hospital, Jaipur on 80 patients with clinical suspicion of PAD. After approval from institutional research and review board, patients were selected after applying inclusion and exclusion criteria and obtaining informed consent. All patients underwent colour doppler followed by CT angiography. A comparative analysis of arterial system was done by both gray scale and color spectrum doppler analysis on CDUS as well as by

CTA for colour flow, % stenosis, length of involved segment, collateral flow, thrombus, plaque and wall calcification using chi square test.

Inclusion Criteria

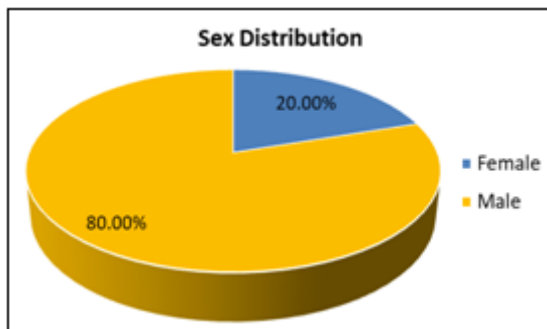
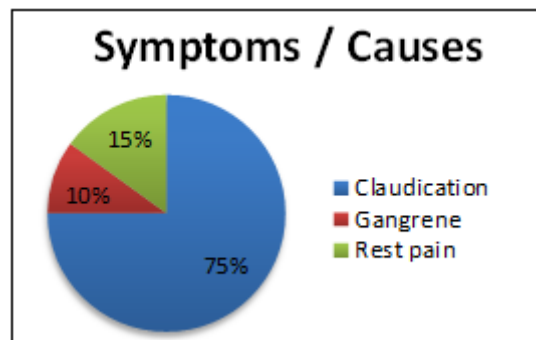
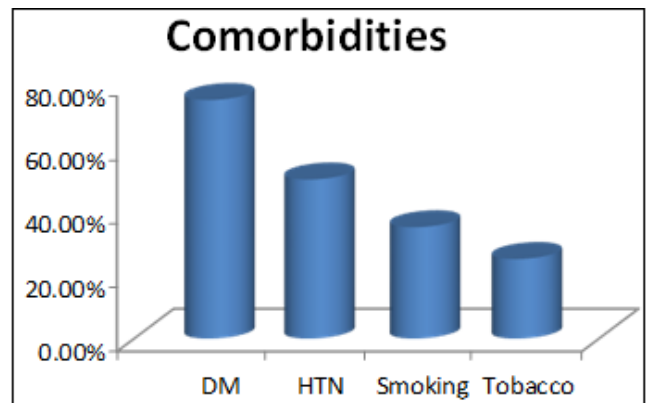
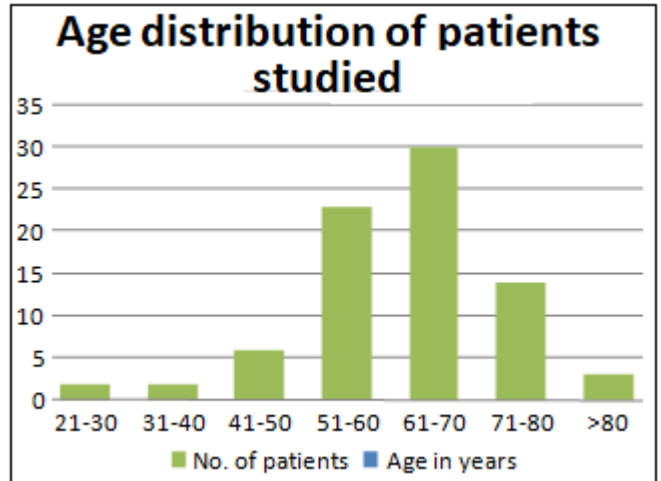
- Patients presenting with lower limb claudication or rest pain.
- Patients with gangrene of lower limb.
- Patients with absent peripheral pulses in lower limb.
- Those who are willing to give written and informed consent to be included in study.

Exclusion Criteria

- Patients with allergic reaction to contrast.
- Patients with upper limb affection.
- Patient with deranged renal function test.

4. Results

In our study, out of 80 patients, 64 patients (80%) were male and 16 (20%) were female with majority of patients were of middle to elderly age group with highest number of patients in 61-70 years age group i.e. 30 patients (37.5%). Major risk factors associated with most of the patients were diabetes (75%) and hypertension (50%). 75% patients suffered from some form of claudication whereas 10 % patients had gangrenous features in limbs and 15% patients had complain of rest pain. Out of 640 arterial segments studied on both CTA and CDUS in our study, CTA picked up abnormality in 370 segments (57.85%) whereas colour Doppler was positive in 400 segments (62.5%). CDUS detected <50% stenosis in 220 arterial segments, 50-75% stenosis in 50 arterial segments, 75-99% stenosis in 10 arterial segments and occlusion (100% stenosis) in 90 arterial segments. Doppler overestimated the stenosis by 1 grade in 46 arterial segments and 2 grades in 2 arterial segment. Doppler underestimated the stenosis by 1 grade in 52 arterial segments.



The overall sensitivity and specificity of CDUS compared to CTA in femoro popliteal segments was found to be 92.25% and 88.04% respectively. Overall PPV and NPV was 91% and 89.6% respectively.

Comparison with Previous Studies

	Done by	Sensitivity %	Specificity %	Accuracy %	Agreement	Study
CTA v/s DSA	Carlo catalano <i>et al</i> [84]	96	93	94	NA	n=50, 4 MDCT
	Jurgen K <i>et al</i> [85]	96	97	NA	-	n=39 16, MDCT
Doppler v/s DSA	Sensier <i>et al</i> [86]	98	81	-	K=0.81	PSV considered
	Koelemay <i>et al</i> [87]	86(74-91)	97 (94-99)	NA	-	Meta-analysis
	Mc carthy <i>et al.</i> [88]	NA	NA	-	K=0.81	CFI considered
Doppler v/s CTA	Amlendu Nagar <i>et al</i> 2016[22]	92.9	82.2	85.6	73.4 %	n=75, PSV&CFI considered 128 MDCT
	Prem Kumar Chidambara m <i>et al</i> 2016[21]	93	82	86	75%	n=50, 64 MDCT
	OUR STUDY	92.25	87.75	-	-	N=50, 128 MDCT

The above comparison table shows that our study is in agreement studies mentioned above with high correlation between CDUS and CTA in evaluating stenosis in PADs in lower limb arteries.

The sensitivity, specificity, PPV and NPV of the arterial segments in present study:

S.NO.	Parameters	Sensitivity	Specificity	PPV	NPV
1	collateral	90.5%	88.8%	48.66%	99.5%
2	Extent short segment/long segment	93.8%	98.85%	99.1%	92.52%
3	Thrombus	57.15%	96.5%	73.5%	91.5%
4	Plaque	93.6%	96.6%	96.1%	93.8%
5	Wall calcification	91.5%	94.6%	92.6%	92.65%

5. Discussion

Peripheral arterial disease (PAD) is an important cause of morbidity among elderly males. Other than vascular claudication, several conditions may simulate intermittent claudication. Hence Doppler USG and angiography is indicated for outlining anatomy and assessing vascular narrowing as preliminary examination.

Catheter-based DSA used to be the reference standard for evaluation of limb ischemia. Spiral CT demonstrating vascular diseases was well documented since early 1990s. CTA has now replaced catheter-based angiography for clinical assessment of the aorta and its branches.

Doppler USG has many benefits like no risk of radiation, repeatability, functional evaluation of blood flow, velocity quantification and direct measurement of thrombus, dilatation or narrowing. Use of Doppler USG is restricted by a small window; wide inter observer variability, limited reproducibility and long examination time. CTA using single shot IV injection of non-ionic contrast material reproduces entire arterial anatomy within 2-3 minutes. Interpretation of axial, MPR images, maximum intensity projection (MIP) and volume rendered (VR) technique requires approximately 10-15 min. Depiction of arterial reformation and collaterals are better with CTA, however

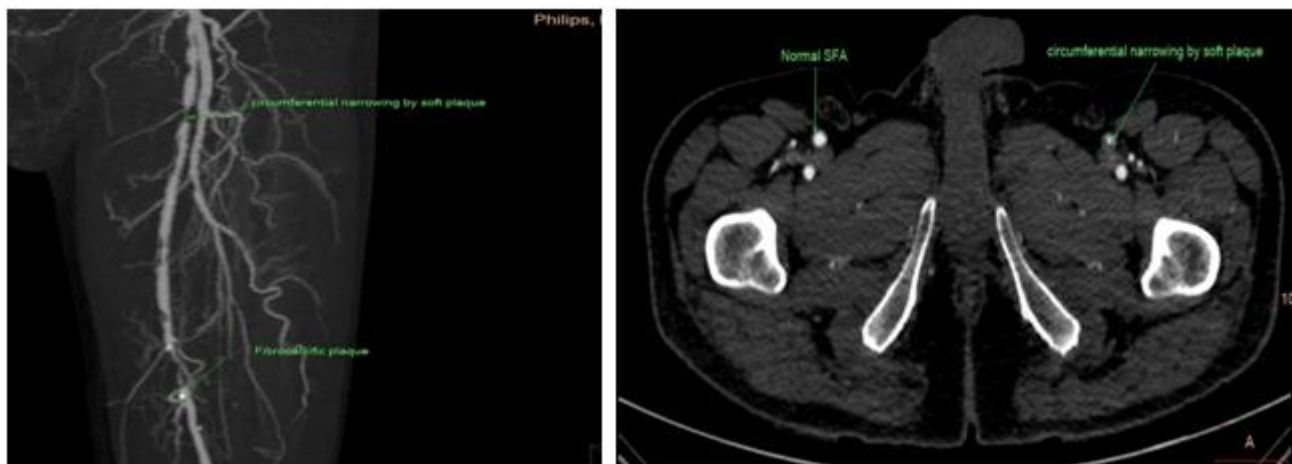
limited to determine the direction of flow. Limitations of CTA are use of radiation, compromised renal function and repeatability. In our study, none of our patients required repeat CT angiography. Grading of arterial stenosis was done using axial images in CTA and B mode images in Doppler USG.

The overall sensitivity and specificity of CDUS compared to CTA in femoro-popliteal segments was found to be 92.25% and 88.04% respectively. Overall PPV and NPV was 91% and 89.6% respectively. In our study we found CDUS to have good correlation with CTA in evaluation of PADs in lower limb vessels.

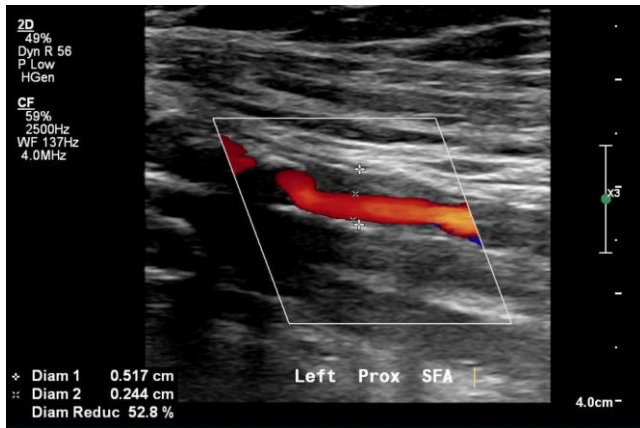
6. Conclusion

Colour doppler imaging is safe, popular, cost effective, easily available, repeatable, non-invasive procedure for investigating lower limb arteries in comparison to CT Angiography.

CDUS favour's to be the 1st line investigation for evaluation of PADs followed by CT before planning any interventional treatment especially in femoropopliteal segments, low grade stenosis and eccentric stenosis.



CT Angio shows circumferential narrowing of proximal left SFA by soft plaque on axial and coronal images



Doppler USG show around 52% narrowing in proximal SFA by plaque

References

- [1] Weitz JJ, Byrne J, Clagett GP, Farkouh ME, Porter JM, Sackett DL, Strandness DE Jr, Taylor LM. Diagnosis and treatment of chronic arterial insufficiency of the lower extremities: a critical review. *Circulation*. 1996 Dec 1; 94(11):3026-49.
- [2] Rahul J. Shirol, Aathish Shetty, Chethan T. K. Role of MDCT in Evaluation of Peripheral Vascular Disease of the Lower Limb Arteries and Comparison with Colour Doppler. *Journal of Evolution of Medical and Dental Sciences* 2015; Vol. 4, Issue 54, July 06; Page: 93369346.
- [3] A R Owen and G H Roditi. Peripheral arterial disease: the evolving role. *Postgrad Med J*. 2011 Mar; 87(1025):189-98.
- [4] Rubin GD, Schmidt AJ, Logan LJ, Sofilos MC. Multi-detector row CT angiography of lower extremity arterial inflow and runoff: initial experience. *Radiology*. 2001; 221(1):146-58